The radial distribution function (rdf) of 
MOO$_3$-P$_2$O$_5$ glass system with the use of 
dopants and without have been determined 
from x-ray diffraction. The rdf peaks are 
assigned as corresponding to P-O, MO-O, 
(O-O)$_P$ and (O-O)$_MO$ distances. 
Correspondingly the coordination numbers 
under the peaks have also been determined. 
On the basis of the rdf studies the authors 
infer the glass structure of the compounds 
as corresponding to tetrahedral configuration 
for both the cations and there are a 
certain number of non-bridged Oxygen ions 
which are mutually arranged in tetrahedral 
configuration around unoccupied holes. The 
Oxygen tetrahedra are sharing only corners 
and not edges or faces. The use of 5% 
dopents(Mn$^{2+}$ or Co$^{2+}$) replacing MO$^{2+}$ leads 
to a more unfold type of structures.

22.3-4 Ultrastuctural and Analytical Studies of 
Amorphous Calcium Phosphates, Pyrophosphates 
and Phosphate-Pyrophosphate Complexes 
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Amorphous calcium phosphate (ACP) is a long 
standing controversial subject in biomineralization 
processes, especially new bone formation. Although 
Grynpas et al. (J. Met. Soc. 19:723, 1984) have shown by x-
diffraction radial distribution function (rdf) that 
there is no detectable amount of ACP in either embryonic or 
mature bone (<1%), the possible role of ACP as a labile 
intermediate transforming rapidly into impure poorly 
crystalline calcium apatite as found in bones cannot be 
ruled out. Moreover ACP has been suggested to be present 
in intracellular and extracellular (in lower species only) 
calcium deposits suggesting that ACP may be stabilized by 
some ambient agents including Mg$^{2+}$, pyrophosphate (PPI) 
and glycosaminoglycans. 
PPI has been found by Cheng and Pritzker (J. 
Rheumatol. 18:769, 1983) to be especially potent in 
inhibiting the ACP-apatite transformation. Also Mg$^{2+}$ 
ions inhibit this transformation by competing with Ca$^{2+}$ 
and retarding crystallization. In a set of solutions 
containing orthophosphate (P) and PPI as well as Ca$^{2+}$, 
Mg$^{2+}$, Na$^+$, Cl$^-$ in concentrations similar to in vivo values, 
the stable solid products formed were (A) mixtures of 
monoclinic and triclinic calcium pyrophosphate dihydrate 
(CPPD-MT), (B) precipitates amorphous to x-ray 
diffraction, (C) calcium apatite crystals, depending on 
the solution P/PPI values: 3, 3-180, >100 respectively. 
This predicts calcium apatite bone in a high P/PPI 
environment and calcified articular cartilage and intervertebral discs form CPPD-MT crystals in a low 
P/PPI environment.

When studied by transmission electron microscopy, 
precipitates (B) do not give any crystalline forms nor 
electron diffraction patterns. Precipitates (B) when 
aired-dried show morphology consisting of spheroids with 
electron lucent centers. (Fig. 1) similar to that of ACP as 
reported by Weber et al. (Arch. Biochem. 120:723, 1967). 
However, when dehydrated through graded alcohols, they 
show a very different morphology consisting of extremely 
fine particles with diameters as small as 1 nm (Fig. 2), 
suggesting that precipitates (B) are truly amorphous. 
However, the confirmation of the amorphous structure of 
precipitates (B) awaits our RDF studies now being 
undertaken. 
Precipitates (B) have been tentatively assigned to 
be ACP, amorphous calcium pyrophosphate (ACP-P), amorphous 
calcium pyrophosphate-phosphate complexes (ACP-P) 
according to their Ca/P ratios (close to 1.5, close to 1.6, 
in between, respectively) which vary with by 
physical chemical parameters. However, spectroscopic and chemical 
studies are underway to quantify the amounts of Ca$^{2+}$, Mg$^{2+}$, P and PPI in the 
three groups.

While both intra- and extracellular ionic Ca$^{2+}$ 
concentrations in vivo are highly regulated, those of 
Mg$^{2+}$, PPI, and P are subject to wide fluctuations. As 
the solid phase formation is closely related to the ambient 
ion concentrations, the clarification of the 
interrelationships of crystalline and amorphous calcium 
phosphates and pyrophosphates, Ca/P and P/PPI ratios 
and other physical chemical parameters will provide insight 
into the conditions in which physiologic and pathologic 
calcifications form.